

# Science and Technology

## *Science and Technology Critical Outcomes*

Six Critical Outcomes governed performance of work at DOE's Pacific Northwest National Laboratory in fiscal year 1998:

- develop and deploy new environmental technologies
- deliver more and better research and development for each dollar
- increase the scientific and technical contributions of DOE
- operate the Laboratory with distinction, supporting the Science and Technology Mission and protecting workers, the public, and the environment
- provide leaders and systems that effectively support the mission areas of DOE
- involve and benefit local and regional communities to remain a valued community asset.

## *DOE Business Lines*

DOE supports the development of science and technology for America's future by focusing its resources on four primary business lines:

- Environmental Quality
- Energy Resources
- National Security
- Science and Technology.

*There is a single light of science,  
and to brighten it anywhere is to  
brighten it everywhere*

*Isaac Asimov*

Hanford's Science and Technology Mission ensures that the single light of science illuminates and shines ever brighter at Hanford and throughout the world. The partnership between DOE and its contractors has enabled Hanford science and technology to achieve significant success in fiscal year 1998 in all mission areas of DOE. This success is aligned at the highest level among DOE's four primary business lines: Environmental Quality, Energy Resources, National Security, Science and Technology, as well as a fifth line, Corporate Management. This partnership is embodied in six Critical Outcomes: Environmental Technology, Scientific Excellence, Scientific and Technical Contributions, Operational Excellence, Leadership and Management, and Community Relations.

DOE and several other public and private agencies sponsor Hanford's multi-program Science and Technology Mission activities. Each sponsor has key strategies and performance measures aligned with its activities. Synthesizing the various strategic objectives and aligning them is fundamental to accountability for progress. The Critical Outcomes enable this synthesis of strategic objectives and align them with the imperatives of institutional stewardship.

Significant scientific and technological excellence is an appropriate hallmark for a Science and Technology Mission and a national asset like the Pacific Northwest National Laboratory. The high value placed on an innovation-enhancing work environment, strong emphasis on safety and institutional stewardship, and the acknowledged prominence as a citizen of the surrounding community are the elements that ensure Hanford's activities comprise the best overall investment in science and technology available to the DOE.

The focus on Critical Outcomes has enabled scientifically sound, cost-effective, and timely solutions to the needs of Hanford, the region, the nation, and, indeed, the world. Science and technology, the solution- and outcome-oriented, sustaining mission at Hanford and its enduring resource, Pacific Northwest National Laboratory, are contributing in significant ways to moving the DOE toward a new legacy of service to the nation and a world that is more safe, secure, and sustainable.

## Science and Technology Contributions to Critical Outcomes

In fiscal year 1998, Hanford achieved success in all Critical Outcomes, which support DOE's business lines. This success is attributable to the partnership between DOE and its Laboratory contractor, which involves developing a joint vision of outcomes and accompanying performance indicators to gauge progress. This section details the scientific and technological excellence attained during the year for the primary DOE business lines, as well as Corporate Management highlights.

## Environmental Quality

As a principal DOE laboratory for the Environmental Quality business line, the Laboratory is contributing to reducing health and environmental risks associated with legacy waste production sites and current operations. A key role is to deliver the knowledge required to make scientifically sound, risk-based decisions and provide technology that reduces the cost and improves the timeliness and effectiveness of environmental remediation. Specific to Hanford, the Laboratory is contributing to major programs such as Spent Nuclear Fuel, Hanford Tank Waste Remediation, Environmental Restoration, and Groundwater/Vadose Zone.

The Laboratory provides technical leadership to DOE's Tanks Focus Area. The Tanks Focus Area is responsible for development and complex-wide integration of technical solutions to enable and enhance the remediation of DOE's tank waste at four major tank sites: Hanford, the Idaho National Engineering and Environmental Laboratory, the Oak Ridge Reservation in Tennessee, and the Savannah River Site in South Carolina. Key to this program is the timely, cost-effective application of technology solutions to treat and retrieve tank waste at multiple sites, thus maximizing the investment in the technology's development. One technology deployed at Hanford in 1998 which will have far-reaching benefit to the various tank waste sites is the corrosion probe monitor.

Also addressing waste issues at Hanford is the Waste Disposal and Integration Team, a multi-contract team led and primarily staffed by the Laboratory. The team, chartered to support Hanford's tank waste program, plays a key role in the development and execution of DOE's strategy for expediting cleanup of Hanford's tank waste. A major milestone in fiscal year 1998 was signing BNFL Inc. to a multi-billion dollar contract to provide the long-term solution to cleanup of Hanford's tank waste and also to protect the Columbia River.



***Developing cost-effective, highly efficient technologies is key to remediating radioactive tank waste. In 1998, an advanced electro-chemical corrosion monitoring probe was installed in a Hanford tank. The probe effectively measures corrosion buildup in the tank, allowing workers to determine when and how much corrosion inhibitor is needed. As inhibitor creates additional waste, the probe is projected to save millions of dollars in unnecessary waste immobilization costs at Hanford.***

## Fiscal Year 1998 Corporate Management Highlights

- RL extended Battelle's contract to operate the Laboratory through September 2002. The performance-based contract features even greater emphasis on Laboratory performance against the Critical Outcomes.
- For the first time, important community feedback was collected on a national laboratory's value to its community. The highly positive response will allow enhanced focus on corporate citizenship issues.
- The Laboratory's Operations Improvement Program was successfully closed out, with key information gained and important management techniques now being applied at other DOE sites.
- A new report published in 1998 shows science and technology activities are contributing to job creation, economic diversification, and reducing the community's reliance on federal jobs.

## Science and Technology Near-Term Challenges

Cultivating even greater opportunities for Hanford technology deployments, and increasing new technology deployments at Hanford are key challenges for fiscal year 1999.

## Science and Technology Accomplishments

- The Laboratory was awarded its first-ever rating of Outstanding in fiscal year 1998. Extraordinary success in the Environmental Molecular Sciences Laboratory's first year of operation, successful Phase 1 and 2 verification of the Integrated Environment, Safety, and Health Management System, outstanding performance in scientific excellence, and a highly effective self-assessment program were among the achievements cited by RL in its rating of the Laboratory.
- In fiscal year 1998, 24 technologies were deployed by Bechtel Hanford, Inc. and the Project Hanford Management Contract companies, resulting in a 110 percent increase over the target of 11 deployments for the year.
- The Laboratory was awarded \$8.3 million in research projects for DOE's Environmental Management Science Program, about one-third of the total EMSP funding allocated in 1998 to address the nation's most complex environmental cleanup problems.
- Almost 700 users from academia, other national laboratories, and industry conducted research in DOE's Environmental Molecular Sciences Laboratory in its first full year of operation.

In fiscal year 1998, 24 technologies were deployed by Bechtel Hanford, Inc. and the Project Hanford Management Contract companies, a 110 percent increase over the target of 11 deployments for the year. The technology deployments occurred in several key programs, including the Canyon Disposition Initiative, C Reactor Interim Safe Storage, Tank Waste Remediation System, and Waste Management. Many of the technologies also were deployed at other DOE sites, commercial sites, and even the Chernobyl reactor complex in Ukraine. The Laboratory deployed 13 technologies at other sites, including a technology used by United Nations inspectors.

### Energy Resources

In the area of energy resources, the Laboratory is engaged in a diverse range of work aimed at understanding the relationship between the environment and energy. For example, the many methods of worldwide electrical generation are producing health and environmental concerns. Laboratory researchers are among the nation's leaders in global climate research, and are involved in assessing the impacts of climate change by producing decade-to-century length predictions of regional climate differences resulting from natural and human influences. The Laboratory's research is advancing the world's understanding of these and other problems, and developing solutions to mitigate harmful environmental effects.

In fiscal year 1998, the Laboratory helped establish an independent energy efficiency center in Ukraine. To date, six centers in Eastern Europe and China have been created to promote economic growth and energy efficiency in countries facing high energy consumption and growing fossil fuel emission troubles. The centers provide expertise to business and government leaders regarding environmental policy development, energy management training, technology transfer, public education, and research.

The Northwest Alliance for Transportation Technology, a partnership with DOE,



***Lightweight, fuel-efficient vehicles will bring environmental, energy, and economic benefits to the United States. DOE, the Laboratory, and industry are teaming to meet 21st century transportation demands by developing the new generation vehicle.***

the Laboratory, and private industry, is making progress on developing a new generation vehicle. This 21st century automobile will be low-cost, lightweight, generate far less pollution, and post 80 miles per gallon of fuel. Advanced metal-forming techniques pioneered at the Laboratory will provide needed strength and eliminate excess weight.

Working to ensure reliable, cost-efficient, and environmentally friendly power sources is another area of specialty at the Laboratory. Here, advancements are being made in the development of solid oxide fuel cells for both industrial, large-scale use as well as smaller units for automobiles and even backpack battery chargers. With fewer moving parts than conventional combustion engines or turbine systems, these highly efficient fuel cells can come on line quickly, emit vastly fewer harmful emissions to the environment, and are quiet. The fuel cells could be incorporated into large power generation stations as early as 2002.



## National Security

Laboratory staff are engaged in solving many of the country's national security challenges, particularly in the area of non-proliferation and counterintelligence. Much of the Laboratory's work in national security has far-reaching, global benefits, including the recent development of two devices that can detect nuclear detonations. These devices, Automated Radioxenon Sampler/Analyzer and the Radionuclide Aerosol Sampler/Analyzer, will be located around the globe and used to monitor compliance with the Comprehensive Test Ban Treaty.

In fiscal year 1998, advancements were made in the international safety arena when the United States and the Democratic People's Republic of Korea reached a Framework Agreement for the safe storage and ultimate disposition of that country's spent nuclear fuel. The Laboratory had the lead role for coordinating the storage and transportation of 8,000 plutonium fuel rods out of North Korea, marking the end of plutonium production in that country.



**Officials from the departments of Justice, Defense, and Energy, along with Vice President Al Gore, received a firsthand demonstration at the White House this year of the interactive, sophisticated ScenePro software system. ScenePro will enable law enforcement personnel to quickly capture vital amounts of information at crime scenes. The demonstration was part of a DOE national laboratory event featuring technologies that will be used by the FBI and other law enforcement organizations.**

The Laboratory will play a dominant role in a new DOE initiative to help former Soviet Union nuclear cities diversify their economies. Under the Nuclear Cities Initiative, cities with economies formerly dependent upon the design, assembly, and production of the Soviet nuclear arsenal will apply the valuable skills of their scientists and engineers to develop new, peaceful enterprises. The Laboratory's widespread experiences in the former Soviet Union, and its emphasis on assisting with diversifying the economy of the local Mid-Columbia region, make it a perfect match to aid in this new effort.

The Laboratory also manages DOE's International Nuclear Safety Program with support from other national laboratories, U.S. commercial organizations, and governmental and scientific institutions in nine host countries. Program activities focus on reducing risks at 65 Soviet-designed nuclear power plants, which is accomplished by transferring modern safety technology and helping to create self-sustaining infrastructures that ensure these countries are on a path toward internationally accepted safety standards.

On another front, a technology originally designed in support of treaty inspections and other arms control and verification activities will bring new capabilities to law enforcement personnel. Called ScenePro, this interactive system enables users to quickly capture, store, and relay vast amounts of information at crime scenes and other field scenarios. The system will be field tested by law enforcement personnel in major U.S. cities in 1999.

## Science and Technology

The Laboratory contributes to the Science and Technology business line on a number of fronts, but particularly in the area of environmental sciences and delivering leading-edge technologies critical to DOE missions. Leveraging research opportunities through science partnerships and collaboration with universities, national laboratories, and other public and private organizations is critical to achieving success.

## Lab's Integrated Safety System a Verified Success

The Laboratory's Integrated Environment, Safety, and Health Management System won approval during verification activities conducted in June 1998 by representatives of DOE-Headquarters, RL, and other DOE field offices.

The Laboratory was the first national laboratory to receive a positive result on its system, and was the first to be scrutinized under both Phase 1 and Phase 2 verification concurrently.

Phase 1 verified that the Laboratory has developed the processes necessary for integrated environment, safety, and health systems, while Phase 2 validated that those systems were being implemented and were effective.

DOE has mandated development of integrated safety management systems at all sites within the DOE complex. The goal is to fully integrate environment, safety, and health into day-to-day management and work practices at all levels.

In addition to enhancing safety, integrated safety management will help enable world class science.

"Making this system happen is important for science to survive, to be vital, and to be at the frontier," said Dr. Martha Krebs, director of the DOE Office of Energy Research, during the On-Site Review at the Laboratory in August 1998.



***In 1998, Ukrainian workers repaired a damaged ventilation stack at Chernobyl, resolving a significant safety issue. The 64-meter (210-foot) stack was in jeopardy of falling on the shelter over the ruined Unit 4 reactor or the operational Unit 3 and injuring workers.***

***A Laboratory team worked with Ukrainian specialists to develop a plan that significantly reduced radiation exposure to workers involved with the repair efforts. Flags of the United States, Ukraine, and Canada—the three countries that funded the repair work—fly in recognition of the international contributions to the project.***



***(Upper right photo) Significant progress was made in fiscal year 1998 to protect workers and the environment from potential collapse of the 20-story, 305,000 metric ton (336,000 ton) concrete and steel shelter constructed hastily in 1986 to contain radioactivity from the Chernobyl Unit 4 nuclear accident. Among the major safety initiatives accomplished this year were the installation of a neutron monitoring system, providing equipment and training to reduce worker exposure to radiation, supplying equipment to suppress radioactive dust in the shelter's access areas, and providing industrial safety equipment and training for worker protection.***



The Laboratory continues to play a major role in the DOE's Environmental Management Science Program (EMSP), a national effort to effectively address the nation's most complex environmental cleanup challenges by tapping into more than 37 laboratories and educational research institutions to develop solutions. The Laboratory has a lead role in new EMSP research programs that focus on issues related to high-level radioactive tank waste and vadose zone problems. Last year, the Laboratory was awarded 13 EMSP projects totalling \$8.3 million.

In fiscal year 1998, the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), DOE's newest national scientific user facility sponsored by the Office of Biological and Environmental Research, surpassed expectations for its first full year of operations.

Almost 700 users from academia, other national laboratories, and industry conducted research in EMSL during the fiscal year, and program research funding grew to \$18.3 million compared to the target of \$16 million. The increase was



***The molecular beam epitaxy and chemical vapor deposition systems in the EMSL are used to produce thin-film materials with well-defined surfaces. These surfaces then are used in studies of interfacial chemical reactions that are relevant to environmental remediation issues at DOE sites.***

due to funding obtained for a range of areas, including atmospheric chemistry, health effects, environmental management, natural and accelerated bioremediation, geosciences, and computation. A growing research area involves advancing the state of the art in computational modeling and simulation and developing advanced computing and collaboration technologies.

In delivering high-value technologies, Laboratory staff were recognized with seven R&D Magazine 100 Awards, tying with Lawrence Livermore National Laboratory for the most awards won by a national lab in a year. The technologies have application to environmental cleanup, national security, improved environmental processes, medical procedures, industry improvements, and emissions monitoring.

The Laboratory also captured three Federal Laboratory Consortium Awards for Excellence in Technology Transfer, with technologies designed for soil remediation, management of nuclear data, and more efficient text retrieval and analysis. The awards recognize outstanding work in

transferring U.S. government-sponsored technologies to the public and private sectors.

Continuing aggressive efforts in the development of science and technology will ensure that Hanford cleanup and other vital DOE missions are accomplished, bringing shining solutions well into the 21st century for environmental, energy, security, and health care-related issues.